obtaining a counter frequency variation of reflection coefficient of high-frequency power based on a sweep-frequency of the high-frequency power and the detected result of the reflection amount of high-frequency power.

According to the apparatus of the invention, it is possible to easily measure the plasma absorption frequency as the plasma density information.

In the apparatus of the invention, it is preferable that the apparatus further includes a dielectric division wall interposed between plasma and the sweep-frequency type high-frequency power supplying means. According to this structure, since the dielectric division wall interposed between plasma and the sweep-frequency type high-frequency power supplying means is provided, it is possible to maintain the plasma clean.

In the apparatus of the invention, it is preferable that the apparatus includes the above-described plasma density information measuring probe, and high-frequency power is supplied from the antenna in the tube to plasma using a tube wall of the dielectric tube as a division wall, a plurality of antennas are accommodated in the dielectric tube such that distances between a tip end of the tube and the antennas are different from one another, and the power reflection coefficient frequency characteristics obtaining means obtains a counter frequency variation of reflection coefficient of high-frequency power for each of the antennas, and a plasma absorption frequency appearing at the same frequency in the counter frequency variations is obtained as a plasma surface wave resonance frequency. With this structure, it is possible to easily measure the plasma density information, and to generate the spatial resolution. In addition, it is possible to easily obtain the plasma surface wave resonance frequency from the counter frequency variation of reflection coefficient of the high-frequency power from the antennas having different distances from the tip and of the tube.

In the apparatus of the invention, it is preferable that a plasma density information measuring probe is inserted in a chamber which generates plasma for forward and backward movement, and the probe is moved such that a tip end of the probe is pulled backward from a measuring position in the chamber to a retreat position in the vicinity of a wall surface of the chamber when measurement is not carried out. With this structure, since the probe is moved such that a tip end of the probe is pulled backward from a measuring position in the chamber to a retreat position in the vicinity of a wall surface of the chamber when measurement is not carried out, even if the plasma allows stains to adhered to the surface of the probe, it is possible to move the probe toward the plasma only when the measurement is carried out, to prevent the probe from being contaminated, and to keep using the probe for a long time.

In the apparatus of the invention, it is preferable that protecting means for blocking excessive plasma generating high-frequency power which enters the antenna in the probe is provided behind the plasma density information measuring probe. With this structure, when excessive plasma generating high-frequency power enters the antenna in the probe, the protecting means provided behind prevent the excessive high-frequency power, thereby preventing the apparatus from being destroyed. Especially when the generated plasma disappears unexpectedly, there is an adverse possibility that the high-frequency power for generating the plasma is directly placed on the antenna, and the probe control section is destroyed. However, this adverse possibility is overcome by the protecting means.

BRIEF DESCRIPTION OF THE DRAWINGS

For the purpose of illustrating the invention, there are shown in the drawings several forms which are presently preferred, it being understood, however, that the

invention is not limited to the precise arrangement and instrumentalities shown.

Fig. 1 is a block diagram showing a plasma processing system according to an embodiment of the present invention;

Fig. 2 is a vertical sectional view showing a measuring probe used in the system of the embodiment;

Fig. 3 is a transverse sectional view showing the measuring probe used in the system of the embodiment;

Fig. 4 is an equivalent circuit diagram of a directional coupler used in a plasma density information measuring apparatus;

Fig. 5 is a sectional view showing a position changing state of a loop antenna in a measuring probe;

Fig. 6 is a graph showing reflection coefficient frequency characteristics of high-frequency power for measuring the plasma density information;

Fig. 7 is a graph showing the relationship between plasma absorption frequency and length of tip end of a tube of the measuring probe;

Fig. 8 is a vertical sectional view showing a modification of the measuring probe;

Fig. 9 is a vertical sectional view showing another modification of the measuring probe;

Fig. 10 is a block diagram showing a modification of a probe control section;

Fig. 11 is a block diagram showing another modification of the probe control section;

Fig. 12 is a partial sectional view showing the measuring probe and probe moving means;

Fig. 13 is a partial vertical sectional view showing a modification of a coaxial